Rim Fire Restoration
Stanislaus National Forest

News *flash*

July, 2015

When the earth moves under our feet….

Soil is one of the most complex ecosystems on the planet, hosting a quarter of the biodiversity found on earth within its layered realms. It filters and stores our water and the nutrients needed to grow food. Native seeds are banked in the soil, allowing new plants to colonize an area impacted by disaster. When covered by forest litter and vegetation, it also helps to stabilize hillsides.

So what happens when large sections of the landscape are burned? What becomes of the soil then?

"Soil is one of those things we tend to take for granted," said Curtis Kvamme, District Soil Scientist, Stanislaus National Forest, "until the earth moves under our feet. Then soil gets our full and riveted attention. "

Following a large wildland fire, like the Rim Fire, the earth can slide, slump, dump or deposit many things. "During a rainstorm, large volumes of ash and soil can cut loose and slide downhill," said Kvamme. "This can happen in an even layer across the whole hillside, or in small channels (rills), the size of a pencil. Larger channels, called gullies, which can be as wide and deep as a car, can also form. Sometimes, these events can be made worse by chemical changes that happen due to the fire."

"When organic matter is burned," said Kvamme, "it vaporizes fatty acids and other compounds. These compounds sink down through the pores of the soil and clog them up. As that fatty layer solidifies, it creates a slick layer beneath the soil's surface that can repel water. Depending upon topography and the amount of precipitation, water may run off the surface, causing much more soil to be lost above this repellant layer."

Debris flows are triggered in steep canyons when a rain event of significant proportion occurs. Following a wildfire, the lack of stabilizing vegetation encourages running water to pick up sand, rocks and even boulders, creating a fast moving river of floating geologic material. The speed and enormity of the carried particles can be devastating for anything lying within its path. Models created by the U.S. Geological Survey help to predict the potential for these events.

Debris flows, flash floods and sedimentation...

Debris flows, flash floods and sedimentation deposits are other dramatic events that can occur after a fire. "During debris flows," said Kvamme, "huge boulders can get swept up in a sea of gurgling mud only to be dumped downstream when the energy of the flow dissipates. This happened on Lumsden and Cherry Lake Roads this past winter, in several locations. Though these events were minor compared to what could happen, they moved some pretty big boulders. You can see some of the deep stream channels that were cut during the event."

Flash flooding is another potential side-effect of intensely burned hillsides. Warning signs include a sudden change in water color from clear to a muddy brown or a rapid rise in water levels.

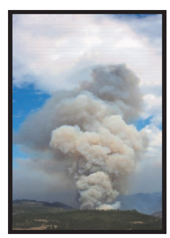
If you see this type of action in a burned area, you need to get out of the area quickly. It doesn't need to be raining right where you are standing for this to happen. Upstream rain events can readily trigger flash flooding downstream, especially in tight river canyons.

"Sedimentation problems differ from debris flows," said Kvamme. "In this instance, the water is flowing more smoothly than in a rock-strewn debris flow." For reservoirs, this is still an issue. Removing the ash and particulates costs many millions of dollars.

Because scientists knew soils were vulnerable following the fire, numerous safety measures were put into place quickly. "Mitigating post-fire effects is a large part of what we do," said Kvamme.








Research at work: determining the effectiveness of erosion controls

Research is conducted to answer intriguing questions or to help inform managers of a scientifically based, cost-efficient course of action. Stabilizing burned slopes following a fire is important, but what methods are best suited to accomplish the goal?

Scientists are exploring that question on the Stanislaus. Rice straw, in quantities of ¼ , ½ and 1 ton per acre, was applied to 28 burned study plots, in order to stabilize the soil. The study's premise is to determine the amount of straw needed to efficiently stop erosion, without driving up cost by applying too much. Forest debris trapped by silt fences, which are located below the straw, will help to answer this effectiveness question over the next few years.

Scientific models to the rescue

When post-fire field assessments have been completed, scientists start crunching numbers into models like the Erosion Risk Management Tool (ERMIT). "By calculating the length of the slope as well as its steepness," said Lizandra Nieves-Rivera, Soil Scientist for the Stanislaus, "we can calculate erosion potential. Other factors that come into play are the texture of the soil as well as how much rocky material is present."

"The goal is to see trouble before it arrives," said Nieves-Rivera, "that way we can proactively work on the most dangerous issues. Though post-fire erosion events can pass quickly, the consequences can be both devastating as well as far-reaching."

Outputs from ERMIT are linked to climate data for the area. "That matches expected weather patterns with the burned landscape," said Nieves-Rivera. "The end result is that you gain an idea of what portions of the landscape are most at risk during a precipitation event. This is one way we can use science to help protect communities near the Forest."

To test for hydrophobicity, soil scientists use the "water drop test." This entails pouring a small amount of water on a patch of burned soil to see if the water beads up on the soil's surface rather than absorbing into it.

Rills and gullies are erosional features that form on the landscape when not enough litter and duff or vegetative matter is present to slow rain drops down. If you've every wondered where the term " gully-washer" comes from, this should give you a hint.




Soil burn severity

The effects of fire on the soil are induced by heating. Soils are left intact in most areas with reduced fuel loads and low heat transfer, but when fires burn an area more severely, and linger over the same place for a long time, the hydrologic function of the soil can be harmed. It comes down, in part, to the pores or air pockets found between clumps of "dirt."

"These passageways allow for the movement of gases, air and water," said Kvamme. "If a fire super-heats the soil, it can change the soil biologically, chemically and even structurally. When that happens, soil functions are drastically reduced." Water may run off the slope instead of filtering slowly through the soil's layers. Topsoil can get eroded and some plant nutrients are lost through burning or leaching rather than being recycled by soil organisms.

That's why scientists like Kvamme use soil burn severity (SBS) maps and field samples to quickly assess soil damage following a fire. "We want to determine if the fire has created unacceptable risks to life and property."

Satellite imagery and infrared are used to create a SBS map after a large incident has occurred. "This allows you to see fire-induced changes to the soil," said Kvamme. "These changes can impact raindrop infiltration, runoff and erosion."

Map results are either verified by flight or (cont.)

2015 is the International Year of Soils

- "Land, then, is not merely soil; it is a fountain of energy flowing through a circuit of soils, plants, and animals." Aldo Leopold
- "Most of all one discovers that the soil does not stay the same, but like anything alive, is always changing and telling its own story. Soil is the substance of transformation." Carol Williams
- "Each soil has had its own history. Like a river, a mountain, a forest, or any natural thing, its present condition is due to the influences of many things and events of the past." Charles Kellogg
- "The soil is the great connector of lives, the source and destination of all. It is the healer and restorer…" W. Berry

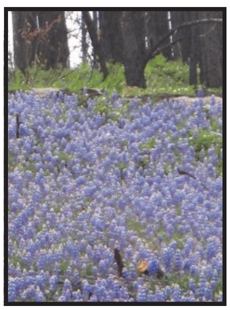
Soil burn severity, continued

ground-truthing. To examine SBS closely, scientists look at the depth of the charring to determine how much organic matter has been lost. “The actual structure and color of soil can change,” said Kvamme. “It really depends on how much heat transferred from the surface fuels into the mineral soil horizons.”

“The reason we pay so much attention to soil burn severity after a fire,” said Kvamme, “is because it can have dramatic effects on how landscapes recover after the fire is out. The soil burn severity determines how quickly vegetation regrows. It also impacts the availability and diversity of the seeds that are left to sprout. Sediment delivery to streams is another factor that is impacted by SBS along with the overall watershed response. Then you have to factor in the hazards that are created that can impact property as well as people.”

One of the biggest issues that concerns soils scientists is how much top soil is lost over a broad area. “Most of the plant-available nitrogen is held within the top 12 to 14 inches of the soil, so if that burned and erodes away,” said Kvamme, “you can lose some plant productivity on the site.”

Top soil nitrogen can be a limiting factor for many plants following a wildfire. In most cases, heated soil mineral layers can compensate for this by releasing nitrogen. “Meanwhile, plants like lupine and deer brush that have the ability to fixate their own nitrogen, through specialized root nodules, have an advantage over those that don’t,” said Crispin Holland, Forest Biologist, Stanislaus National Forest. “Over time, these nitrogen fixing plants incorporate that component back into the soil, making the site more hospitable to the next succession of vegetation.”






Some potential soil effects

Physical Effects

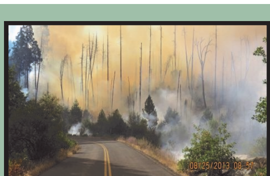
- Loss of organic matter
- Loss or reduction of soil structure
- Reduction of porosity
- Change in soil color
- Water repellant layer can form
- Clay minerals can be destroyed
- Increase in soil temperatures

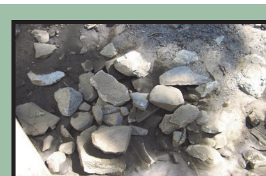
Chemical Effects

- Increase in pH
- Loss of nutrients by volatilization (turning into gas) or by leaching
- Minerals can oxidize
- Hydrophobic (water-fearing) layer of soil can form and that encourages rain to runoff

Biological Effects

- Mortality of soil organisms
- Seeds can be whisked away in post-fire events
- Top soil can be lost
- Plant roots & fungus are damaged
- Biodiversity is decreased




“Soil is complex and alive,” said Kvamme. “The more I learn about it, the better I appreciate what soil does.”